APPENDIX A

RECORD OF DECISION
SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

ADMIRAL HOME APPLIANCES
SUPERFUND ALTERNATIVE SITE
WILLISTON, BARNWELL COUNTY, SOUTH CAROLINA

Prepared by
United States Environmental Protection Agency
Region 4, Atlanta, Georgia

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TABLES

LIST OF ACRONYMS and ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Regulations
ATV	Alternate Toxicity Value
BDL	Below the laboratory Detection Limit
BERA	Baseline Ecological Risk Assessment
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	Chemical of Concern
COPC	Chemicals of Potential Concern
EPA	United States Environmental Protection Agency
EPA-OTS	EPA Region 4 Office of Technical Services
ENSR	Engineering Consultant Firm retained by Dixie-Narco to prepare RI/FS
EPS	Exposure Pathway Scenarios
ERA	Ecological Risk Assessment
ESD	Explanation of Significant Differences
ESI	Expanded Site Inspection
FS	Feasibility Study
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
Hg	Mercury
HQ	Hazard Quotient
IRIS	Integrated Risk Information System
LOAEL	Lowest Observed Adverse Effects Level
MCL	Maximum Contaminant Level
MEP	Maximum Extent Practicable
mg/kg	milligrams per kilogram or parts per million (ppm)
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effects Level
NPL	National Priority List
O&M	Operation and Maintenance
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbons
ppb	parts per billion
ppm	parts per million
PRG	EPA Region 9 Preliminary Remediation Goals
RAO	Remedial Action Objectives
RBC	EPA Region 3 Risk Based Concentrations
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager

SARA	Superfund Amendments and Reauthorization Act of 1986
SCDHEC	South Carolina Department of Health and Environmental Control
SDWA	Safe Drinking Water Act
SESD	EPA Region 4 Science and Ecosystem Support Division
SI	Site Inspection
SQL	Sample Quantification Limit
SVOCs	Semi-Volatile Organic Compounds
TAL	Target Analyte List
TCE	trichloroethylene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxicity Equivalence Quotient
µg/kg	micrograms per kilogram
µg/L	micrograms per Liter
US	United States
US FWS	United States Fish and Wildlife Service
VOCs	Volatile Organic Compounds
yd^3	cubic yards
<	less than

SAMPLE NOMENCLATURE

Samples collected during the RI/FS were assigned a unique sample identifier. This identifier was used throughout the sample collection, analysis, and reporting activities, and will be clearly linked to a sample location name, depth indication, and quality assurance/quality control (QA/QC) identifier. The identifier contained a sufficient number of characters to include this information as described below. This information was recorded in both field logbooks and the project database management system. Prefixes used to identify matrix spike sample, matrix duplicates, re-analyzed samples, and samples re-analyzed at a secondary dilution were appended by the laboratory and included in all laboratory deliverables in accordance with USEPA Region IV protocol. The sample identifiers were clearly shown on the chain-of-custody form and sample container labels.

The field identifier code includes the following:

- two-digit code to indicate the round of sample collection (e.g., 01, 02, 03, 04, etc.)
- two-to-four-digit code to indicate the type of sample location,

SB	=	Soil Boring
SW	=	Surface Water
MWS	=	Monitoring Well Soil
MW	=	Monitoring Well
TMWS	=	Temporary Monitoring Well Soil
TMW	=	Temporary Monitoring Well
SD	=	Sediment
TP	=	Test Pit Sample
RW	=	Residential Well

- one-to-three-digit number to indicate the boring, well, or sample location ID number,

  (e.g., 1, 2, 100, 201, 304, etc.)

- one or two letter code to indicate sample depth,

  (e.g., A, B, C for increasing soil depths, S = shallow, D = deep, D2 = intermediate-deep, or D3 = deep-deep), and

- one-letter code to indicate field quality assurance samples.
  - A = Analytical Sample
  - B = Duplicate Sample
  - C = Equipment Blank Sample

An example of a complete soil sample identification number is 01SB1AA, which designates a soil sample collected in the first round from the shallowest depth interval at SB-1. An example of a complete groundwater sample identification number is 02MW21SB, which designates a duplicate groundwater sample collected in the second round from monitoring well MW-21S.

The trip blanks were tied to a specified cooler and used the Chain-of-Custody tape number as the sample identification number preceded by "TB".

PART 1: THE DECLARATION

1.1 Site Name and Location

This Record of Decision (ROD) is for the Admiral Home Appliances Superfund Alternative Site located in Williston, Barnwell County, South Carolina. The National Superfund Database, also known as CERCLIS, identification number for this site is SCD04756314.

A Remedial Investigation and Feasibility Study (RI/FS) was prepared for this site and serves as the basis for this Record of Decision along with the companion documents, a Human Health Baseline Risk Assessment and a Baseline Ecological Risk Assessment. The site consists of one operable unit, although there are separate component remedies for resolving contamination problems from a former wastewater treatment system equalization lagoon (S alternatives), the groundwater (GW alternatives), and the sediments, soils, and surface water in the former wastewater plant discharge area and downstream (SHSSW alternatives) along an adjacent stream leading to Willis Millpond. The chosen component remedies are jointly identified as the Selected Remedy. The RI/FS was conducted by Dixie-Narco, Inc. pursuant to an Administrative Order on Consent (AOC) signed on September 25, 2000.

1.2 Statement of Basis and Purpose

This decision document presents the Selected Remedy for the Admiral Home Appliances Site in Williston, South Carolina, which was chosen in accordance with CERCLA, as amended by SARA, and to the extent practicable, the NCP. This decision is based on the documents contained in the Administrative Record file for this site. The State of South Carolina concurs with the Selected Remedy.

1.3 Assessment of the Site

The response action selected in this Record of Decision is necessary to protect the public health and welfare and the environment from actual or threatened releases of hazardous substances from this site into the environment. Inadequately treated wastewater has impacted a wetland discharge area, downstream Spur Branch, and Willis Millpond. Several contaminants discharged from the manufacturing plant have impacted groundwater in the area. A remaining equalization lagoon, now located beneath the Dixie-Narco parking lot, has impacted the site as well.

1.4 Description of the Selected Remedy

The three selected components (preferred alternatives) of the Selected Remedy are as follows:

1.4.1 Equalization Lagoon (S-2)

The Selected Remedy for the equalization lagoon includes the following:

- Excavation with off-site disposal of contaminated material that exceeds clean-up levels.

- Confirmatory sampling of soils to verify that material exceeding clean-up levels has been removed.

- Backfilling of the excavated area and covering with asphalt and/or concrete.

1.4.2 Groundwater (GW-4)

The Selected Remedy for groundwater includes the following:

- Enhanced Reductive Dechlorination (ERD) to remediate TCE and CT contamination.

- Monitored Natural Attenuation (MNA) to address dissolved contaminants in groundwater.

- Quarterly sampling of 20 residential wells downgradient of the site.

- Provision of bottled water to residential well users with mercury detections until public water supply is available (bottled water is currently provided and public water supply is anticipated to be in early 2007).

- Additional investigation to identify onsite source(s) of mercury contamination.

1.4.3 Discharge Area, Wetlands, & Stream (SHSSW-2)

The Selected Remedy for SHSSW-2 includes the following:

- Removal and off-site disposal of sediments and hydric soil south of Charleston Street to the former Imhoff System.

- Confirmatory sampling south of Charleston Street to the former Imhoff System to verify that material exceeding clean-up levels has been removed.

- Full wetland and stream bank restoration in accordance with state and federal requirements.

- Monitored Natural Attenuation (MNA), including toxicity testing, of sediment, hydric soils, and surface water further downstream from Charleston Street to and including Willis Millpond.

- As a contingency, based on MNA results, the remedy could be expanded to include additional excavation downstream of Charleston Street to and possibly including Willis Millpond.

1.5 Statutory Determinations

The Selected Remedy satisfies the statutory requirements of CERCLA. The Selected Remedy attains the mandates of CERCLA Section 121 and to the extent practicable, the NCP.

1.5.1 Part 1: Statutory Requirements

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate (ARARs) to the remedial action, are cost effective, and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable.

1.5.2 Part 2: Statutory Preference for Treatment

The remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment.)

1.5.3 Part 3: Five Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this Record of Decision (Part 2). Additional information can be found in the Administrative Record file for this Site.

- ✔ Chemicals of concern and their respective concentrations (pages 28-45)
- ✔ Baseline risk represented by the chemicals of concern (pages 48-59)
- ✔ Cleanup levels established for chemicals of concern and the basis for these levels (pages 67,83,84)
- ✔ How source materials constituting principal threats are addressed (page 78)
- ✔ Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the Baseline Risk Assessment and ROD (page 81)
- ✔ Potential land and groundwater use that will be available at the site as a result of the Selected Remedy (page 81)
- ✔ Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (pages 113-130)
- ✔ Key factor(s) that led to selecting the remedy (i.e. describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (pages 77-80)

1.7 Authorizing Signature

9-28-06

Beverly H. Banister, Acting Director
Waste Management Division

Date

PART 2: THE DECISION SUMMARY

2.1 Site Name, Location, and Brief Description

The AHA Site is located southeast of the Town of Williston on County Road 65 in Barnwell County, South Carolina. The geographic coordinates of the site are 033 degrees, 23 minutes, 38.4 seconds north latitude and 081 degrees, 23 minutes, 49.9 seconds west longitude. Figure RD-1 presents a site location map based on the United States Geological Survey (USGS) Williston, South Carolina 7.5-minute topographic quadrangle. The AHA Site has been divided into the following areas:

- Dixie-Narco, Inc. (Dixie-Narco) manufacturing plant;
- Former equalization lagoon;
- Wooded area bounding the northeast side of the manufacturing plant;
- Storage and parking area, former transfer pipe area, and field south of Dixie-Narco Boulevard;
- Imhoff system (removed in January and February of 2005);
- Imhoff system wetland area (discharge area),;
- Intermittent Spur Branch stream (intermittent stream);
- Spur Branch (perennial) stream;
- Willis Millpond;
- Willis Millpond spillway (spillway) and Spur Branch stream just beyond the County Road 65 bridge.

Each portion of the study area is shown in more detail on Figures RD-1 and RD-2. The National Superfund Database, also known as CERCLIS, identification number for this site is SCD04756314. The RI/FS was conducted by Dixie-Narco pursuant to an AOC signed on September 25, 2000. EPA is the lead agency at the site. EPA will pursue a settlement with the Potential Responsible Parties (PRPs) to fund this remedy.

The Dixie-Narco manufacturing plant area is bounded on the east by County Road 65 (Dixie-Narco Boulevard), on the south by East Main Street, on the west by the refurb plant and an undeveloped wooded area, and on the north by County Road 215 (Elko Street). The manufacturing plant is currently used for the manufacturing of soft drink vending machines.

The former equalization lagoon, which is located immediately northeast of the manufacturing plant building, is not in use and has been capped with clay and asphalt. The lagoon, with approximate dimensions of 30 feet wide by 40 feet long and 8 to 9 feet in depth, received wastewater from the plant and allowed for settling of solids. Wastewater was pumped from the equalization lagoon through the transfer pipe beneath Dixie-Narco Boulevard to the Imhoff system. The portion of the transfer pipe from the

equalization lagoon to County Road 65 has been removed. Several documents reviewed indicate that the contents of 172 drums, with the approval of the SCDHEC, were placed into the lagoon and mixed with the sediment prior to its closure. During the RI, sampling activities determined that the waste layer in the bottom of the lagoon is approximately 2.5 feet thick. The lagoon is underlain by a tight native clayey sand.

The property bounding the northeast corner of the plant property is primarily wooded and privately owned. An intermittent stream that exits the northeast side of the manufacturing plant parking lot, runs through this parcel, beneath Dixie-Narco Boulevard and eventually discharges into the intermittent Spur Branch stream (Figure RD-2).

The storage and parking area and field southeast of Dixie-Narco Boulevard (County Road 65) are owned by Dixie-Narco. The parking area includes a storage building and open areas used for storage of supplies for Dixie-Narco. A small wooded area abuts the east end of the parking area. This wooded area is bounded on the north and east sides by an open field. The former transfer pipe for the wastewater system runs from Dixie-Narco Boulevard beneath the field to the northwest end of the Imhoff tank. The former transfer pipe and other components of the former wastewater treatment system are described later in this section of the report.

The Imhoff system area is located to the southeast of the manufacturing plant and Dixie-Narco Boulevard. While the property the former Imhoff system is located on was privately owned and farmed in the past, the property has since been purchased by Dixie-Narco. The Imhoff system was connected on its northwest side by the transfer pipe and bounded on its southeast side by the discharge area or Imhoff wetland area. It is surrounded on all other sides by wooded areas. A description of the former Imhoff system operation is included later in this section.

The intermittent portion of the Spur Branch stream traverses the east side of the Imhoff wetland area, discharging to the northeast. The intermittent portion of the Spur Brach stream extends for approximately 1800 feet from the northeast side of the Imhoff wetland area under Charleston Street and to Ralph Road. The intermittent stream may run dry during periods of low rainfall.

The perennial portion of the Spur Branch stream extends from Ralph Road to the east-northeast for approximately 1.5 miles where it discharges into the Willis Millpond. The stream continues beyond Willis Millpond for several miles, intersecting other small millponds before it eventually discharges into the South Fork of the Edisto River.

The Willis Millpond area is approximately eight acres in size. It is bounded on the north by the spillway and Willis Pond Road (County Road 65). In May 2003, the dam for the millpond breached due to heavy rainfall. Material from the pond washed north into the spillway and beyond Willis Pond Road. The dam breach reduced the coverage of the pond to approximately 3 acres.

The pond spillway area is bounded by Willis Millpond on the south and Willis Pond Road, on the north. The downstream portion of the perennial Spur Branch stream investigated during the RI extends from Willis Pond Road north for approximately 450 feet.

2.2 Site History, Investigations, and Enforcement Activities

In 1952, prior to the construction of the manufacturing plant, the Imhoff system, consisting of an above ground Imhoff septic tank, a sludge drying bed, a trickle filter, and a polishing tank, was constructed by Robbins Trailer Corporation to treat sanitary sewerage generated by a trailer park situated at the current location of the Dixie-Narco manufacturing plant. The Imhoff system was constructed on property owned by Celonia Sapp located adjacent and to the east of the trailer park. Robbins Trailer Corporation was granted an easement by Celonia Sapp on April 8, 1952, to use the Imhoff system for sewerage disposal. The trailer park discharged domestic sanitary sewerage to this Imhoff system from 1952 until 1966.

In May 1966, Chill Chest, a division of Revco, constructed and began operating a refrigerator/freezer manufacturing plant at the current location of the Dixie-Narco plant. The refrigerator/freezer plant constructed an equalization lagoon on the manufacturing plant property and discharged industrial and sanitary wastewater to this lagoon. The wastewater was then piped beneath County Road 65 (Dixie-Narco Boulevard) to the Imhoff system and then was discharged towards the intermittent portion of the Spur Branch stream.

Several acquisitions involving the manufacturing plant took place during the period from 1968 to 1981. In 1968 Guerdon Industries acquired Revco. In 1969, City Investing Company acquired Revco and Guerdon Industries. In 1979, Revco became the Refrigeration Products Division of Rheem Manufacturing Company. In 1981 the Williston plant site was acquired by Magic Chef of which Admiral Home Appliances was a division. In 1986, Maytag Corporation acquired Magic Chef and all of its companies, including Dixie-Narco. In 1989, Dixie-Narco moved production of vending machines from Ranson, West Virginia to the Admiral Home Appliances freezer factory in Williston, South Carolina. In September 1989, Dixie-Narco began manufacturing soft drink vending machines at the plant.

Between approximately 1971 and 1989, the facility operated a fork lift repair shop and paint booth. These structures were located on the north central side of the plant. Between 1971 and the early 1990s, the plant underwent a series of renovations and expansions. In the early 1990s, the fork lift repair shop and paint building were dismantled. The plant was expanded to the north and an access road for to the rear parking lot was installed over the former locations of the paint booth and forklift repair shop. During the expansion and road building activities the native soil in this area was reportedly disturbed, re-distributed and then paved over by the access road.

The Imhoff system received industrial wastewater from the various refrigerator/freezer plant operations from 1966 until October 1982, when the new operator, AHA, disconnected the system and began discharging to the Town of Williston wastewater treatment plant. In 1971, the Imhoff easement was transferred to the Town of Williston, and they continued to operate the Imhoff system until October 1982, when the system was shut down. By that time, the Town of Williston had constructed a new wastewater treatment plant and the AHA plant began to discharge to the new treatment facility. In 1982, after the Imhoff system was shut down, the portion of the piping leading from the equalization lagoon to Dixie-Narco Boulevard was removed.

From review of historical documents and discussion with plant personnel, the pre-1982 manufacturing process at this plant consisted of forming and stamping of steel into freezers. The processes included conversion coating and spray-booth painting. The conversion coating process used an alkali solution to clean the metal, a zinc-phosphate spray to prepare the surface and a chromic acid cleaner to enhance paint retention. It was reported that the zinc-phosphate spray also contained nickel. It was also reported that the spray booths and paint spray nozzles were cleaned with solvents including toluene, xylene, methyl ethyl ketone and diethylene glycol monobutyl ether. Prior to 1982, the wastewater generated from this process was routed through the equalization lagoon and the Imhoff system.

The Imhoff system contained the Imhoff tank, a trickle filter, and a sludge drying bed. Wastewater from the equalization lagoon was pumped through the transfer pipe into the main, baffled tank of the Imhoff tank structure. Solids precipitated out of the wastewater in the baffled tank. Wastewater would then flow into a small holding tank (polishing chamber). Water in the polishing chamber was then pumped into the trickle filter through a series of pipes (six pipes) oriented east to west across the top of the trickle filter. Wastewater discharged into the trickle filter through a series of approximately four spray heads located on each of these pipes. Wastewater then trickled down through the granite cobbles that fill the trickle filter structure. Wastewater then discharged from the trickle filter into a discharge pipe on the southern end of the trickle filter. The discharge from the Imhoff system was piped through a wetland area toward the intermittent portion of the Spur Branch stream.

The Imhoff system discharge pipe was partially buried and extended approximately 125 feet to the east from the trickle filter. Prior to the preparation of the RI/FS Work Plan a break was noticed in the discharge pipe, approximately 50 feet from the east side of the trickle filter. If the break occurred during the Imhoff systems operation, it is possible that the break in the discharge pipe may have allowed effluent wastewater to discharge into the flat, wetland area adjacent to the intermittent stream.

The intermittent Spur Branch flows to the northeast where it eventually becomes the perennial arm of the Spur Branch. Approximately two miles downstream of the Imhoff system, Spur Branch has been dammed to form an approximately eight-acre millpond (known as Willis Millpond). Following a breach, the size of this Millpond has been reduced to approximately three acres. Other tributaries also merge into Spur Branch

between the Imhoff system area and the millpond. Spur Branch flows approximately nine miles northeast to the South Fork of the Edisto River.

During the operation of the Imhoff system, sludges from the Imhoff tank were periodically removed and placed into the adjacent drying bed. According to Dixie-Narco personnel, sludge was never removed from the sludge drying bed and shipped off-site. After closure of the system, sludges from the equalization basin were removed, temporarily drummed, later removed from the drums, placed back into the basin, covered with a clay cap and then paved. According to plant sources, no sludges were shipped off-site for disposal.

During operation of the Imhoff system, the South Carolina Department of Health and Environmental Control (SCDHEC) conducted numerous National Pollutant Discharge Elimination System (NPDES) inspections. These inspections noted violations including flow exceedances, improper record keeping, and discharge of industrial wastewater to a system designed to accept sanitary sewer waste.

Rheem Manufacturing Company conducted a removal action in January and February of 2005 to remove the Imhoff system. The Imhoff tank, sludge drying beds, trickling filter, and the transfer pipe from Dixie-Narco Blvd. to the Imhoff tank were removed. The contents of the Imhoff tank, sludge drying beds, and trickling filter were removed as well. The removal action was conducted by Rheem pursuant to an Administrative Order On Consent (AOC) signed on July 16, 2004.

During the late 1970's and early 1980's, SCDHEC and AHA representatives collected surface water, sediment, soil, and groundwater samples during the equalization lagoon and Imhoff system's operation. In order to illustrate the number of samples collected, the concentrations of chemicals detected, and the approximate locations of the collected samples, a brief chronology of these sampling events is provided below. The discussion provided below does not include samples collected by SCDHEC for NPDES permit requirements. Most of these samples did not provide testing for the RI/FS chemical constituents of potential concern.

On November 26, 1979, SCDHEC initiated a special study at the AHA Site to collect data for issuance of pretreatment parameters for discharge to the municipal sewage system that was to be constructed. The study included the collection of effluent samples associated with the Imhoff system, a sediment sample from the flooded low land below the plant outfall, and surface water samples collected at the following locations:

- Culvert on County Road 215;
- Bridge below Willis Millpond on County Road 65; and
- Spur Branch at bridge on County Road 32.

The sediment sample results indicated cadmium at a concentration of 20 mg/kg, chromium at 18,000 mg/kg, nickel at 18,000 mg/kg, and zinc at 150,000 mg/kg.

On August 14, 1981, SCDHEC initiated an additional special study of the Williston/Rheem Company discharge receiving waters. This study was conducted to provide additional supportive data to that collected in November 1979. The study included the collection of water samples from the effluent generated from the plant, the unnamed tributary to Spur Branch, Willis Millpond, and Spur Branch at County Road 32. Additionally, sediment samples were collected from the unnamed tributary to Spur Branch, Willis Millpond and Spur Branch at County Road 32.

On August 27, 1982, the SCDHEC returned to the AHA Site and collected sediment samples from the swamp area adjacent to the Imhoff system. According to the SCDHEC laboratory, analysis could not be performed on the sediments due to a low flash point. AHA representatives then collected additional sediment samples from the swamp area and results of the laboratory analysis did not yield low flash points. SCDHEC collected additional sediment samples from the swamp area in January 1984 for laboratory analysis. None of the swamp samples were analyzed due to a reported low flash point.

A document entitled *Williston/Chill Chest Waste Water Treatment Plant, Site Investigation Plan* dated January 15, 1988, prepared by MBA Management Inc. on behalf of the Admiral Division of Maytag, was submitted to the SCDHEC for approval and subsequent implementation. The work plan outlined an investigation of impacts to soil/sediment in the vicinity of the Imhoff system. Soil samples were collected in a radial pattern centralized around the end of the discharge pipe leading from the Imhoff system. Soil samples were collected at the ground surface, 12 inches below ground surface (bgs), and 24 inches bgs. Results indicated the presence of chromium at concentrations as high as 15,217 milligrams per kilogram (mg/kg) in one of the soil samples collected at the surface. At 12 inches below surface, the chromium concentration at this location decreased to 437 mg/kg, and then to 129 mg/kg at 24 inches below surface. Other sample locations yielded similar results. Nickel concentrations were detected as high as 20,652 mg/kg in a soil sample collected at ground surface. This location yielded a concentration of nickel at 911 mg/kg at 12 inches below the surface, and 242 mg/kg at 24 inches below ground surface. Zinc was detected at concentrations as high as 83,696 mg/kg, also in a soil sample collected at ground surface. This location yielded concentrations of zinc at 3,214 mg/kg and 937 mg/kg at 12 inches and 24 inches below ground surface, respectively.

In 1989, the SCDHEC initiated a sampling event and collected soil and groundwater samples from the AHA Site and surrounding properties. Results of this investigation were published in the Site Screening Investigation dated 9/29/1989. Three private water wells were sampled (one upgradient and to the south of the AHA Site and two downgradient and to the northeast of the AHA Site). Additionally, four sediment/soil samples including a background soil sample, a composite sample collected near the end of the discharge pipe, a wet-weather stream sample collected from downgradient of the Imhoff tank, and a sample collected from beneath the former equalization lagoon were analyzed.

One of the downgradient wells, AHA PW-02, yielded concentrations of aluminum, chromium, nickel, and zinc above the background concentrations detected in the

groundwater sample collected from AHA PW-003. It was indicated in the sampling report that none of these reported concentrations are above maximum contaminant levels (MCLs) or secondary maximum contaminant levels (SMCLs). Volatile Organic Compounds (VOCs) were not detected in the groundwater samples above the laboratory detection limits with the exception of 1,1- dichloroethane. This compound was detected at a concentration of 0.006 mg/l in groundwater sample AHA PW-01. This well is located approximately 900 feet downgradient of the Imhoff system area. SCDHEC did not conclude in their report that the private wells were impacted by site-related constituents.

The composite soil sample, collected from three boreholes completed near the end of the Imhoff tank discharge pipe, yielded concentrations of aluminum (12,200 mg/kg), antimony (29 mg/kg), barium (480 mg/kg), cadmium (11 mg/kg), chromium (10,300 mg/kg), cobalt (46 mg/kg), copper (357 mg/kg), lead (160 mg/kg), manganese (685 mg/kg), nickel (9,460 mg/kg) and zinc (68,900 mg/kg). The composite sample was collected from a depth of 6 to 12 inches below ground surface.

The stream sediment sample, collected from the wet-weather stream downgradient of the Imhoff tank, yielded concentrations of aluminum (4,910 mg/kg), barium (134 mg/kg), chromium (1,250 mg/kg), copper (31 mg/kg), lead (24 mg/kg), manganese (11 mg/kg), nickel (326 mg/kg) and zinc (1,020 mg/kg).

A subsurface soil sample, collected from beneath the area of the closed lagoon, yielded levels of aluminum (15,000 mg/kg), chromium (740 mg/kg), copper (23 mg/kg), manganese (92 mg/kg), mercury (16 mg/kg), nickel (979 mg/kg) and zinc (5,010 mg/kg).

Several organic constituents were detected in the soil samples discussed above. These compounds included bis(2-ethylhexyl)phthalate (9.8 mg/kg), 2,6-dimethyl heptadecane (11 mg/kg), 1,1- oxybisbenzene (9.1 mg/kg) and tricarbonyl (n-phenyl-methyl) iron (12.1 mg/kg).

In January 1989, a USEPA representative collected a sludge sample from the Imhoff tank. Analysis for metals detected chromium at 10,300 mg/kg, nickel at 9,460 mg/kg, and zinc at 68,900 mg/kg. Semi-volatile organic compounds (SVOCs) including bis2(ethylhexyl)phthalate (9.8 mg/kg), 2,b-Dimethy Neptadecane (11 mg/kg), and 1,1-oxbisbenzene (9.1 mg/kg) were also detected in the sludge sample.

In April 1990, Dixie-Narco collected a composite soil sample from the former equalization lagoon and a background soil sample. Each sample was analyzed for Total Petroleum Hydrocarbons (TPH) and several metals.

On May 12, 1993, the SCDHEC collected soil/sediment samples from seven locations downgradient of the Imhoff system. These locations included the beginning of Spur Branch, Boyleston Pond, a tributary from Boyleston Pond leading to Spur Branch, three from Willis Millpond, and a tributary leading to Willis Millpond.

The soil/sediment sample collected near the beginning of Spur Branch yielded concentrations of aluminum (720 mg/kg), barium (5.4 mg/kg), chromium (0.1 mg/kg), manganese (34 mg/kg), nickel (5.3 mg/kg) and zinc (12 mg/kg).

Soil/sediment samples collected from Willis Millpond yielded concentrations of the following constituents; arsenic ranging from 0.5 mg/kg to 6.4 mg/kg; aluminum ranging from 22,000 mg/kg to 27,000 mg/kg; barium ranging from 220 mg/kg to 360 mg/kg; beryllium ranging from 1.0 mg/kg to 1.9 mg/kg; cobalt ranging from 14 mg/kg to 31 mg/kg; chromium ranging from 91 mg/kg to 310 mg/kg; copper ranging from 11 mg/kg to 21 mg/kg; manganese ranging from 120 mg/kg to 260 mg/kg; nickel ranging from 220 mg/kg to 590 mg/kg; tin ranging from 74 mg/kg to 210 mg/kg; vanadium ranging from 20 mg/kg to 38 mg/kg; and zinc ranging from 590 mg/kg to 2100 mg/kg.

A background soil/sediment sample collected from the Boyleston Pond yielded concentrations of aluminum (5200 mg/kg), barium (8.9 mg/kg), chromium (4.4 mg/kg), copper (1.8 mg/kg), manganese, (11 mg/kg), vanadium (14 mg/kg) and zinc (3.2 mg/kg).

Concentrations of metals were detected in the background soil/sediment sample collected from the tributary leading from Boyleston Pond to Spur Branch. The detected constituents included aluminum (14,000 mg/kg), barium (71 mg/kg), beryllium (0.4 mg/kg), cobalt (2.8 mg/kg), chromium (11 mg/kg), copper (3.8 mg/kg), manganese (55 mg/kg), nickel (4 mg/kg), tin (86 mg/kg), vanadium (20 mg/kg) and zinc (13 mg/kg).

The background soil/sediment sample collected from the tributary leading to Willis Millpond from the east yielded detectable concentrations of metals including aluminum (540 mg/kg), manganese (10 mg/kg) and zinc (1.2 mg/kg). No other metals were detected above laboratory detection limits.

On January 11, 1999, soil, sludge and liquid samples were collected from the area around the Imhoff system by representatives of Dixie-Narco and submitted for laboratory analysis. The following samples were collected for analysis; sludge from Imhoff tank for analysis of full Toxicity Characteristic Leaching Procedure (TCLP) list, pH and flash point; liquid from the Imhoff tank for analysis of metals and VOCs, pH and flash point; dried sludge from sludge drying bed for analysis of full TCLP list, pH, fecal coliform and total metals; soil from beneath sludge drying bed for analysis of full TCLP list and pH; soil from adjacent to trickle filter for analysis of full TCLP list and pH; soil from adjacent to Imhoff tank and polishing chamber for analysis of full TCLP list and pH; and soil from effluent pipe break for analysis of full TCLP list and pH.

Results of the laboratory analysis for the soil samples collected indicated non-hazardous concentrations of TCLP metals. In the soil sample collected adjacent to the trickle filter, arsenic was reported at a concentration of 0.021 mg/l. Barium was reported for three of the soil sample collection points at concentrations ranging from 0.123 mg/l to 0.242 mg/l. Other metals analyzed were not detected above laboratory detection limits.

TCLP volatile organics detected in the soil samples analyzed included methylene chloride at a concentration of 484 micrograms per liter (ug/l) in the soil sample collected from adjacent to the Imhoff tank and polishing filter. Additionally, an SVOC, di-n-butyl-phthalate, was detected in three of the soil samples analyzed and concentrations ranged from 34.9 µg/l to 39.8 µg/l. Other TCLP SVOC analytes were not detected.

SCDHEC sampled three domestic water wells on March 18, 1999, for metals and VOCs. The three wells sampled included the Bell well, the Dorch well, and the Sapp well.

Metals detected in the groundwater samples included cadmium at a concentration of 0.0002 mg/l; copper at concentrations ranging from 0.03 mg/l to 0.16 mg/l; magnesium at concentrations ranging from 0.18 mg/l to 0.76 mg/l; manganese at concentrations ranging from 0.01 mg/l to 0.05 mg/l; lead at concentrations ranging from 0.01 mg/l to 0.016 mg/l; and zinc at concentrations ranging from 0.01 mg/l to 0.7 mg/l. The concentrations detected did not exceed the applicable MCLs. VOCs detected included methylene chloride at a concentration of 0.000921 mg/l; 1,1-dichloroethane at a concentration of 0.00191 mg/l; and trichloroethylene at a concentration of 0.000602 mg/l.

In order to determine the extent of contamination at the Site, Dixie-Narco entered into an AOC with the USEPA to perform an RI/FS. The AOC was signed on September 25. 2000. The RI entailed several phases of investigative activities. Analysis of samples collected during the RI was not limited to the original COPCs (metals). During the RI, the COPCs were updated by media as data was collected. This included the addition of VOCs for groundwater beneath the Site.

2.3 Community Participation

EPA and SCDHEC provide information to the public regarding the study and cleanup of the Admiral Home Appliances Site through a variety of activities. There have been three public meetings in Williston regarding the RI/FS at important points in the Superfund process. In addition, one availability session was held in December, 2003. An informal meeting was held by the RPM with area residents in November, 2001 to discuss access agreements for sampling and placement of wells on private property. A formal Public Meeting was held on August 25, 2005 to present the Proposed Plan and receive public input.

The Proposed Plan fact sheet was the sixth fact sheet produced for this Site. Additionally, the RPM, individually or with the EPA Community Involvement Coordinator or with SCDHEC staff has gone door-to-door several times in the adjacent neighborhoods to obtain access agreements for sampling of private water wells, distribute and explain test results, invite residents to meetings, and answer questions on the study. Newspaper advertisements for meetings have been regularly placed in the Augusta Chronicle, the Barnwell County News-Sentinel, and the Aiken Standard. Several radio and television stations from Augusta and Columbia have covered the meetings and interviewed RI/FS staff, including the RPM.

In addition to the meetings, fact sheets, availability sessions and press coverage, there has been significant participation with area government officials, community groups, and national environmental organizations, and State and other Federal Agencies. Numerous freedom of information requests, telephone, postal, and e-mail questions have all been responded to.

The initial public comment period on the Proposed Plan ran from August 23, 2005, to September 23, 2005. The comment period was extended an additional 30 days with newspaper advertisement on October 7, 2005, with a November 8, 2005, end date. Comments received at the August 25, 2005, Public Meeting and during the entire comment period are addressed in the attached Responsiveness Summary to this Record of Decision. Copies of the Administrative Record for the Site are available at both EPA Region 4 and the Williston Public Library.

2.4 Scope and Role of Operable Unit or Response Action

EPA has chosen to use only one Operable Unit for this Site. The remedy has three separate components to address contamination at the old equalization lagoon (the S preferred alternative), the groundwater contamination from the site (the GW preferred alternative), and the Imhoff system area, Imhoff discharge area, and downstream Spur Branch (the SHSSW preferred alternative). The removal and/or treatment methods vary depending on the media. This action will reduce the risks to human and ecological receptors.

2.5 Site Characteristics

During the RI, investigative activities were performed which included the collection of groundwater, soil, sediment, and surface water samples. These activities were performed in four phases between November 2001 and July 2004. This section of the ROD describes the investigative activities performed during the RI.

The RI included the following investigative activities:

- Installation and sampling of 91 temporary monitoring wells;
- Installation and sampling of 11 temporary piezometers;
- Installation and sampling of 65 permanent monitoring wells;
- Collection of groundwater samples from two public water supply wells and 58 private water supply wells;
- Collection of sediment samples and surface water samples from 70 locations including the Spur Branch intermittent stream, Spur Branch perennial stream, Willis Millpond, and several background locations;

- Collection of hydric soil samples from 94 locations and subsurface soil samples from 20 locations in the Imhoff system discharge area and wetland area along the intermittent stream to Charleston street;
- Collection of waste samples from Imhoff system structures and former equalization lagoon;
- Collection of six soil vapor samples from beneath the existing Dixie-Narco plant;
- Geophysical survey of rear parking area at the existing Dixie-Narco plant; and
- Excavation of 24 test pits for subsurface exploration and soil sampling at various locations across the Site.

Locations of the monitoring wells are shown on Table RD-1.

Field investigative activities were performed in multiple phases. Phase 1 of the RI consisted of two sub-phases (Phase 1A and 1B). Phase 1A was performed between November 2001 and February 2002. The purpose of Phase 1A was to investigate the Site for impact from the potential source areas. Phase 1A entailed the collection of samples from contaminant source areas (Imhoff system, former equalization lagoon), a geophysical survey of a portion of the project site, excavation of test pits around components of the former wastewater system (equalization lagoon, transfer pipe, Imhoff system structures), sampling of public and private water supply wells, soil screening in the Imhoff system discharge area/wetland area, sampling of groundwater, screening of sediment in upper section of the intermittent portion of Spur Branch stream, and sampling of sediment and surface water in Willis Millpond.

Phase 1B entailed the installation and sampling of permanent monitoring wells, field screening with the Color Tec methodology, sampling of private water supply wells, sediment and surface water sampling from the Imhoff system wetland area to Willis Millpond, through the millpond spillway area and just beyond Willis Pond Road. Phase 1B was performed between August 2002 and November 2002. The objective of Phase 1B was to expand the investigation of the Site to determine the extent of impact from the potential source areas.

Phase 2 of the RI was initially intended to be a limited phase of investigation to fill data gaps. However, upon review of Phase 1 results, the scope for Phase 2 evolved and was expanded to further define the extent of contaminants in soil and groundwater and perform more specific testing to support risk evaluations. Phase 2A was performed between July 2003 and October 2003. Phase 2A activities included additional monitoring well installation and sampling, additional field screening using the Color Tec methodology, toxicity sampling of hydric soil and sediment, a macroinvertebrate community survey, and sampling of private water supply wells. The purpose of Phase 2A was to refine the investigation with the intent of delineating the extent of constituent concentrations in groundwater as well as the performance of more specific analyses to evaluate human health and ecological risk.

Upon review of Phase 2A data, one additional sub-phase of investigative work (Phase 2B) was performed at the Site. The purpose of Phase 2B was to collect additional data for completion of the RI and to support the feasibility study. Phase 2B entailed the delineation of the extent of VOC concentrations in groundwater beneath the Site, to define the extent of contaminants in hydric soil in the intermittent stream wetland area between the Imhoff wetland area and Charleston Street, and to complete a groundwater to surface water interaction study in the area of the intermittent stream. Phase 2B was performed in June and July 2004.

2.5.1 Conceptual Site Models

Two diagrams, Figure RD-4 and Figure RD-5 in this ROD, depict the conceptual site models for human health and ecological impacts respectively. The conceptual site models provide a graphic representation of the site contaminants, the possible exposure pathways, and the likelihood of exposure by either humans or environmental receptors to the contaminants.

2.5.2 Surface Characteristics

The general area of the Site is included within the sub-basin of the South Fork of the Edisto River. The Site is drained by an intermittent stream that flows in an eastern direction feeding Willis Millpond. Willis Millpond is drained by Spur Branch which flows to the northeast to the South Fork of the Edisto River.

The Site surface gently slopes downward in an easterly direction from the Dixie-Narco plant to Willis Millpond. Elevations at the plant drop from approximately 360 feet mean sea level (MSL) along the northwest side to approximately 340 feet MSL along the southeast side. Surface water drains from the Dixie-Narco plant to an intermittent stream that flows to the south and eventually intersects the intermittent Spur Branch stream, just east of the Imhoff system wetland area.

Surface elevations decrease from approximately 340 feet MSL along the southeast side of the Dixie-Narco plant to approximately 310 feet MSL in the Imhoff system discharge area. The Imhoff system discharge area or Imhoff system wetland area, is a low lying wetland bounding the southern side of the Imhoff system. The intermittent Spur Branch stream intersects the southern side of the Imhoff system discharge area. The intermittent Spur Branch stream is a wet weather stream with a poorly defined braided channel between the Imhoff discharge area and Charleston Street, located to the southeast (Figure RD-2). Beyond Charleston Street, the stream channel becomes more defined and becomes perennial at Ralph Road, approximately three quarters of a mile from the Imhoff system.

The Spur Branch stream flows to the east-southeast from Ralph Road to Willis Millpond (approximately two miles from the Imhoff system). Willis Millpond is a man made pond,

formed by damming the Spur Branch stream. Surface elevations drop to less than 300 feet MSL at the Willis Millpond.

2.5.3 Demography, Land Use, and Climate

The Site is located southeast of the Town of Williston in Barnwell County, South Carolina. Barnwell County is primarily rural with a population of 23,478 in 2004. The Town of Williston is located in the northwest corner of Barnwell County. The population of the Town of Williston is approximately 3,300. The area surrounding the Site is characterized as a combination of agricultural, residential, and commercial/industrial with a significant amount of property remaining undeveloped. Properties directly around the Dixie-Narco Plant are as follows: North – Williston Industrial Park; East – residential properties; South – undeveloped/agricultural land; and West - commercial properties. It is not anticipated that the current pattern of land use will change in the future with implementation of the remedy.

The prevailing climate of Barnwell County is temperate with the summer months being quite warm. Average temperatures in January are 45° F and 80° F in July. The mean yearly precipitation in Barnwell County is 43.1 inches. The summer months are generally wetter with the late fall months receiving the least amount of rainfall. Records also indicates that the spring and summer months of 2003 received significantly more rainfall than average.

2.5.4 Soils

Soils at the AHA Site are of the Dotham and Johnston series with slopes from two to six percent. The higher elevations of the AHA Site are associated with the Dotham series, which consist of deep, well-drained soils derived from loamy Coastal Plain sediments, found on upland ridges and plains. This soil normally has a one-foot surface layer of grayish and light yellowish-brown sand and a five to six foot subsoil of yellowish-brown sandy loam and sandy clay loam with up to 25% plinthite and 5% ironstone nodules. These soils were encountered in borings installed across the Dixie-Narco plant area.

The lower lying areas are associated with the Johnston series soils, which consist of deep, very poorly drained soils formed as loamy deposits in areas of stream overflow. These soils are nearly level, remain moist, and occur near creeks and rivers. Normally they have a surface layer of 38 inches separated into the top 28 inches of black mucky loam overlying 10 inches of very dark gray sandy loam. The subsoil consists of 22 inches of dark gray sandy loam. The Johnston series soils were encountered in the Imhoff system wetland area and intermittent Spur Branch stream.

2.6 Site Geology

Numerous borings were performed at the Site during the RI. The Unified Soil Classification System (USCS) was used to describe the soils encountered during field sampling activities. Lithologic data obtained from these borings has provided information to allow determination of soil layers beneath the Site and correlation of site

specific data with the geologic formations described above. Shallow soils differ in the upland and lowland portions of the Site. The upland portion of the Site is considered to be the area between the western side of the Dixie-Narco plant and the northern side of the Imhoff tank, and includes the entire Dixie-Narco plant, the Dixie-Narco field, and the transfer pipe. This portion of the Site is underlain by layers of inorganic sediments. The lowland portion of the Site extends from the northern side of the Imhoff tank to the southern side of the Imhoff system discharge area/wetland area and encompasses the wetland area bounding the intermittent Spur Branch stream to Charleston Street. This portion of the Site is overlain by a layer of organic rich soils under which lies a series of inorganic sediments.

Soil types encountered beneath the project site range from sandy clays to lean clays to well sorted sands. There are more clay rich soils above the water table in the upland portion of the Site. Several zones of inorganic clay rich sediments are present beneath the western side of the Site. The percentage of clay in soils decreases toward the south, beneath Dixie-Narco Boulevard to the Imhoff system wetland area. Well boring logs also indicate coarsening downward trend; transitioning from clay rich soils to zones of sands and silty sands beneath the water table. Soils encountered in the water table in the upland portion of the Site are likely part of the Upland Unit. Based on soil classification and descriptions included in the previous section, soils encountered below 40 feet BLS in the upland portion of the Site appear to be part of the Barnwell Group. The well MW27D2, one of the deepest wells on-site, was installed into the McBean Formation of the Black Mingo Group.

The percentage of clay rich soils decreases horizontally to the southeast as well as vertically. The shallow wells were installed into the Upland Unit. Other than MW27D, the D zone wells were installed in the sediments of the Barnwell Group. Wells MW5D2, MW5D3, and MW11D2 were installed into the McBean Formation. Inorganic clay rich soils are present beneath the majority of the Dixie-Narco plant. The percentage of clay in subsurface soils decreases to the northwest near MW30D3. The percentage of clay rich zones decreases with depth. Clay rich zones decrease from southwest to northeast in each well boring

2.7 Site Hydrogeology

Four general hydrogeologic units, or aquifers, are recognized in the area of the Site. The uppermost aquifer is the water table or surficial aquifer. The water quality of the surficial aquifer is generally poor with a high iron content and is not typically suitable for potable water supply. The next aquifer system occurs in the Tertiary Units including the Barnwell Group and the McBean, Congaree, and Ellenton Formations. Groundwater usually occurs under semi-confined conditions in the Tertiary Formations. Wells producing from the lower Tertiary sediments could be expected to yield from 50 to 500 gallons per minute (gpm) or more. Private wells are often completed within this aquifer. Beneath the Tertiary aquifer are the Cretaceous aquifers, which in the area of the Site, appear to be hydraulically separated by a clay unit in the Upper Peedee Formation. The Cretaceous aquifers encountered beneath the area include the Black Creek Formation and

the underlying Middendorf Formation. These aquifers are the principal water supply aquifers for the upper Coastal Plain. Often there are productive zones in the upper and lower portions of the Cretaceous sediments, and wells properly constructed in these zones may produce in excess of 2,000 gpm.

Based on the limited information provided by well owners and information provided by SCDHEC, private water supply wells in the area of the Site are generally completed to depths ranging from 70 to 140 feet. Depending on their location and land surface elevation, the shallow private wells sampled during the RI are likely installed in the sediments of the Barnwell Group. The deeper private supply wells (greater than 120 feet) may be installed into the underlying McBean Formation.

Geologically the Site is located in the unconsolidated sediments of the Atlantic Coastal Plain geological province of South Carolina. During the RI, drilling at the Site was conducted to depths ranging to 148 feet below existing land surface. Soils at the Site consisted of sand with varying amounts of silts and clays. Groundwater at the Site was encountered at a depths ranging from approximately 14 feet to 35 feet below land surface in the area of the facility and at depths between approximately one and five feet below land surface in the area of the Imhoff system discharge. Geologic logs show that in general the soils near the water table contain more silt and clays and that the percentage of silts and clays declines progressively with depth. A consistent or laterally continuous clay unit has not been encountered beneath the Site. Soil/well boring logs generated during the RI are included in Appendix A of the RI, available in the Administrative Record.

Groundwater monitoring wells were installed at four general depths during the RI, but confining or isolating clay units were not present between the zones. The depths of these wells were selected by the position of the water table, field screening for VOCs during well drilling, the request by SCDHEC that wells screen zones not be more than 20 to 30 feet apart, and the reported depth of the nearby residential wells. Shallow wells were installed across the water table and generally range from 35 feet to 65 feet deep in the area of the facility and 15 to 20 feet deep in the Imhoff system discharge area. The large variation in depth of the shallow wells in the vicinity of the facility is due to elevation variations. The deeper shallow wells are located in the northwest corner of the Site, which is the highest elevation on the Site. D zone wells were generally installed 20 feet below the shallow wells with well screens located between 55 and 75 feet below land surface. Three of the D zone wells (MW4D, MW5D, and MW8D) were installed with well screens shallower than the other D zone wells. During the Phase 1b portion of the investigation, SCDHEC requested that the D zone wells be installed within the deeper zones that appeared to contain elevated concentrations of chlorinated solvents. During Phase 1B, the Color Tec screening method was used to test for chlorinated ethenes in soil samples from well borings. Based on the field results from the Color Tec screening, the screens for these three wells were installed, as requested by SCDHEC, at depths that contained concentrations of chlorinated organics and not at the same depths as the other D zone wells.

D2 wells were installed with well screens located approximately 25 to 40 feet below nearby D zone wells and with well screens located at depths between 90 and 110 feet below land surface. D3 wells were installed to depths between 116 and 128 feet below land surface. The D2 and D3 wells were designed to approximate the same depths as the residential wells located adjacent to the eastern portion of the Site that had detected concentrations of mercury from an unknown source at concentrations above the MCL.

2.7.1 Groundwater Gradients

A total of 16 rounds of water level measurements were collected over 20 months (November 2002 through July 2004) from the monitoring wells at the Site during the RI. Water levels measurements have been used to prepare piezeometric contour maps to determine groundwater flow directions and horizontal gradients at the Site for each of the four screen zones. Groundwater elevation data from four of these measurement events were chosen to demonstrate the influence of fluctuations in rainfall on hydrogeologic conditions observed during the RI. A groundwater flow map has been prepared for each zone for each of the four measurement events. It is important to note that D2 and D3 wells were not installed until Phase 2A, therefore, flow maps were not available for these zones until late 2003.

The RI contains piezeometric contour maps for each of the four zones monitored beneath the Site (shallow, deep (D), D2, and D3). These maps show that groundwater in the shallow zone generally flows from north across the facility to the southeast and south-southeast to Spur Branch stream where it discharges. The Spur Branch stream in the area of shallow groundwater discharge is an intermittent stream. The actual point of shallow groundwater discharge to the intermittent stream, therefore, will depend on the relative elevations of the shallow groundwater and the bottom of the intermittent stream. In areas where the shallow groundwater elevation is above the intermittent stream bottom, shallow groundwater discharges to the intermittent stream. In areas where the shallow groundwater elevation is beneath the stream bottom, the groundwater will flow towards the stream and then will follow the stream path to the point where the shallow groundwater elevation is above the stream bottom elevation. Groundwater flow in the deep zone generally follows the shallow zone, but with a slightly more southeasterly flow where it follows the stream path of Spur Branch.

The groundwater flow maps for the D2 and D3 zones are less definitive in the direction of groundwater flow largely because there are fewer wells completed in this zone, but these maps show that groundwater in these zones is generally flowing towards the east and southeast.

The groundwater flow maps were used to calculate average groundwater gradients (or slope) across the Site for the shallow and deep zones; there are insufficient wells in the D2 and D3 screen zones to calculate gradients for these zones. Gradients were calculated for each water level measurement round. Gradients were calculated from a point on the upgradient plant boundary to Spur Branch in the Imhoff discharge area. The calculated hydraulic gradients for the shallow zone wells ranged from 0.00279 ft/ft to 0.00638 ft/ft

with an average gradient of 0.00431 ft/ft. The calculated hydraulic gradients for the deep zone wells ranged from 0.006 ft/ft to 0.008 ft/ft with an average gradient of 0.007 ft/ft.

2.8 Surface Water Hydrology

The following section describes the surface water hydrology for the Site and the region surrounding the Site.

2.8.1 Regional Hydrology

The Williston area is located within the Edisto River sub-basin (SCWRC, 1989). This sub-basin includes the North Fork Edisto and South Fork Edisto Rivers. The South Fork Edisto and its tributaries are closest to the AHA Site. The South Fork Edisto River forms the county line between Barnwell and Orangeburg Counties. The headwaters for South Fork Edisto are near the boundary of the piedmont and upper coastal plain, in Edgefield County. This river drains the northern portions of Aiken County and Barnwell County as well as the western portion of Orangeburg County. The South Fork Edisto combines with the North Fork Edisto in southeastern Orangeburg County. The Edisto River continues to the southeast until it discharges to the Atlantic Ocean south of Charleston, South Carolina.

Several tributaries feed the South Fork Edisto River including the Spur Branch stream which runs through the southeastern portion of the AHA Site, the Imhoff wetland area. During periods of normal rainfall in the region, the headwaters of the Spur Branch stream are located approximately 1000 feet to the southwest of the Imhoff wetland area (Figure RD-2).

2.8.2 Site Area Hydrology

Drainage at the Site occurs as overland flow, or at the Dixie-Narco plant through a surface water drainage system. Surface water collected at the Dixie-Narco plant is routed through a storm water discharge line that exits Dixie-Narco property on the northeast side of the rear parking lot (Figure RD-2). This feeds an unnamed tributary that eventually joins the intermittent Spur Branch stream between the Imhoff system wetland area and Charleston Street (Figure RD-2).

The intermittent Spur Branch stream flows to the east-northeast where it becomes more of a well defined, perennial stream at Ralph Road (Figure RD-1). The Spur Branch stream flows further to the east-northeast where it discharges into a man-made private pond, Willis Millpond. The footprint of Willis Millpond covers approximately ten acres. In June 2003, the dam for Willis Millpond breached due to excessive rainfall. This breech reduced the area of surface water coverage from ten acres to approximately three acres. The Spur Branch continues to flow to the north–northeast where it eventually discharges into the South Fork Edisto River.

2.9 Site Ecology

The AHA Site is located in a rural agricultural area in Williston, South Carolina. Spur Branch, an intermittent stream, is located to the northeast of the Site. Forested areas, including palustrine wetlands, are associated with this stream. Approximately one half mile downstream of the Site, Spur Branch becomes a small, first-order perennial stream. Spur Branch discharges to Willis Millpond, a man-made pond located two miles downstream and to the northeast of the Site.

2.9.1 Imhoff System Wetland Area

An Imhoff tank, previously located approximately 600 feet east of County Road 65, received wastewater from the equalization lagoon via piping that crosses underneath County Road 65. The tank was an above-ground concrete structure approximately 30 feet by 20 feet and 10 feet high. The habitat surrounding the Imhoff tank's former location is forested upland with a relatively open understory. Woody vegetation in this region includes pines (*Pinus* sp.), red maple (*Acer rubrum*), sweet gum (*Liquidambar styraciflua*), cherry (*Prunus serotina*), and wax myrtle (*Myrica cerifera*). Other vegetation in this region includes Japanese honeysuckle (*Lonicera japonica*) and catbriar (*Smilax glauca*).

A sludge drying bed was located adjacent and to the southwest of the Imhoff tank. The sludge drying bed covered an area approximately 45 feet by 30 feet. A concrete berm, approximately one foot high, surrounded the drying bed. Limited vegetation, including red maple saplings, were growing in the sludge bed. The trickle filter was located southeast of the Imhoff tank. The trickle filter was approximately 45 feet by 45 feet by seven feet high. The trickle filter consisted of an approximately seven-foot sand and gravel bed contained by a concrete slab and concrete containment walls. Occasional wax myrtle and Japanese honeysuckle grow in and adjacent to the trickle filter's former location.

A low-lying area which served as a discharge area from the Imhoff tank system is located below the former trickle filter location. This area is defined herein as the Imhoff system wetland and is depicted on Figure RD-1. Wastewater was historically discharged from a 12-inch diameter concrete pipe approximately 220 feet southeast of the trickle filter. Limited vegetation was observed in the largely unvegetated discharge area. Flora noted in this region included willow (*Salix* sp.), occasional grasses, and sweet gum. The discharge area drains through a band of tupelo (*Nyssa sylvatica*), with occasional clumps of common reed (*Phragmites australis*). This bottomland hardwood forested swamp becomes more developed several hundred meters from the discharge area, and includes a mixed canopy of tupelo, sweet gum, and sweet bay (*Magnolia virginiana*).

2.9.2 Spur Branch Stream

The discharge from the Imhoff system was historically piped towards an intermittent stream that eventually becomes Spur Branch. Spur Branch in the vicinity of the Site is an intermittent stream. Spur Branch flows from the discharge area to the northeast. The intermittent channel is approximately three feet wide and one foot deep. Overstory includes sweet gum, tupelo, and sweet bay. Understory vegetation in this region includes scrub oak (*Quercus* sp.), royal fern (*Osmunda regalis*), highbush blueberry (*Vaccinium corymbosum*), cat briar, and cinnamon fern (*O. cinnamomea*).

Between County Road 215 and the Site, Spur Branch flows in a dendritic manner through an open forested floodplain with a poorly defined channel; dense vegetation overhangs the 8 to 10 foot wide channel area in this region. Approximately 200 yards downstream of the Site, a few shallow (1 to 6 inch deep) pools of water occur, but no perennial aquatic habitat is present. The bottomland forest soils in this region are highly organic, mucky soils.

At County Road 215, the Spur Branch channel is typically filled with 6-12 inches of standing water. The channel is well defined, approximately 6 to 10 feet wide, with forested floodplain on both sides. Spur Branch flows beneath County Road 215 through two 48-inch culverts. At certain times of year and following rain events, water flows through the culverted Spur Branch under the road. The stream opens up on the northeast (downstream) side of the road and receives flow from a drainage ditch. This area is a tupelo-red maple swamp. Other tributaries also merge into Spur Branch between Ralph Road and the Willis Millpond.

2.9.3 Willis Millpond

Approximately 2,000 linear feet downstream of County Road 215, Spur Branch becomes more of a perennial stream; a dirt road (Ralph Road) crosses the stream at this point. Spur Branch continues to flow for approximately 1.5 miles to into Willis Millpond. The original size of Willis Millpond was approximately 10 acres. However in June 2003, the dam at the north end of the pond breached due to excessive rainfall. The dam break reduced the size of the Willis Millpond from approximately ten-acres to approximately three acres in size. Prior to the break, surface water discharged from the pond through a concrete spillway situated near the east-end of the dam. The break in the dam was between 25 and 30 feet wide and extended approximately 6 to 8 feet down from the top of the dam. The water level in the pond dropped an estimated 4 feet due to the break, exposing a substantial portion of the pond bottom. The pond is now approximately three acres of open water with some limited aquatic macrophytes growing along the perimeter. Along the banks of the pond, sweet gum and tupelo are dominant with occasional pine trees. Similar vegetation is found in the spillway on the north side of the pond.
From the Willis Millpond, Spur Branch continues to flow northeast for approximately eight miles and then discharges into the South Fork Edisto River. The ecological setting beyond the Willis Millpond was not evaluated as part of the RI.

2.10 Types of Contamination and Affected Media

This section presents and discusses the nature and extent of the constituents of concern (COC) in terms of their occurrence and distribution at the Site and by media.

2.10.1 Volatile Organic Compounds

Site related volatile organic compounds (VOCs) were detected on and off site with the most prevalent site related VOCs detected above screening levels being trichloroethene (TCE) and carbon tetrachloride (CT). Other detected site related VOCs included tetrachloroethene (PCE), benzene, 1, 1 dichloroethene (1, 1 DCE), and 1,2 dichloroethane (1,2 DCA). These VOCs were found on-site in a limited number of soil samples collected adjacent to and beneath the Dixie-Narco plant. Site related VOCs were detected in shallow groundwater from the northwest side of the Dixie-Narco plant, beneath the former fork lift repair shop, to beneath the Imhoff wetland area. VOCs were also found in the deeper portion of the surficial aquifer (D zone) from the forklift repair shop to a private parcel of property located southeast of Charleston Street. Based on the risk assessment evaluations, the VOCs benzene, carbon tetrachroride, dichloromethane, 1.1-dichloroethene, tetrachloroethene, and trichloroethylene are COCs for groundwater.

2.10.2 Semi-volatile Organic Compounds

During Phase I of the RI, a limited number of semi-volatile organic compounds (SVOCs) were detected above screening levels in samples collected from the Site. The SVOCs detected most frequently included phthalates and polynuclear aromatic hydrocarbons (PAHs). Only four SVOCs benzo(a)pyrene, benzo(a) anthracene, dibenzo(a,h)anthracene, and bis(2-ethylhexyl)phthalate were detected above their respective residential PRGs. These four compounds were detected above a screening value in only 19 samples collected during Phase 1. None of the SVOCs exceeded their respective industrial PRGs, with the exception of bis(2-ethylhexyl)phthalate in the equalization lagoon. SVOC detections above screening values were sporadic in various media with no correlation to site related source areas with the exception of two detections beneath the sludge drying bed. The sludge drying bed and the soils beneath it were removed as part of the Imhoff System removal in early 2005. Based on the limited number of detections above screening values, and their randomness in nature, SVOCs were eliminated from the analytical suite for samples collected during Phase 2 of the RI, except for those obtained from seven sampled residential supply wells (RW54 through RW60) that were first sampled during Phase 2 of the RI. None of the SVOCs have been identified as COCs in soil, groundwater, sediment or surface water.

2.10.3 Metals

Samples collected during Phase 1 of the RI were analyzed for either TAL Metals or, for some screening samples, a list of possibly site related metals including chromium, nickel, lead, and zinc. Concentrations of arsenic, chromium, copper, iron, nickel, and zinc were

detected above their respective USEPA Region 9 residential PRGs in soil samples collected from the Imhoff wetland area. Metals concentrations above screening values were also detected in sediment in the intermittent Spur Branch stream, and sediment in the Willis Millpond. As a result, during Phase 2 several additional soil and sediment samples were collected from these portions of the Site in order to further evaluate contaminant concentrations, monitor conditions affecting fate and transport, and evaluate soil leaching conditions.

Few metals were detected above their respective MCLs in groundwater samples collected from the Site. Only antimony, lead, and nickel were detected above their respective MCLs in any monitoring wells sampled at the Site through Phase 2. Mercury was detected above its MCL in MW37D, installed northeast of the Site (near RW7) during Phase 2B. Mercury has also been detected above its MCL in four residential supply wells in a small area northeast of the Site. Mercury and Nickel have been included as COCs in groundwater.

The metals arsenic, iron, and manganese were detected above their respective human health screening criteria in surface water samples collected from the Site. The metals chromium, nickel, and zinc were detected above their respective USEPA freshwater sediment ecological screening values. These metals, as well as copper, were also detected above their respective SC Ambient Water Quality Criteria in surface water in the intermittent Spur Branch stream between the Imhoff system wetland and Charleston Street. Chromium, copper, nickel, and zinc have been incli=uded as COCs in surface water. Chromium , nickel, and zinc have also been included as COCs in soils and sediments.

During Phase 1 of the RI, numerous soil, sediment, groundwater, and surface water samples were analyzed for Cr(VI). Each of these samples was analyzed using USEPA Method 7196. Hexavalent chromium was detected in a few samples at low concentrations. However, review of the Phase 1 Cr(VI) results indicated that native conditions at the Site may have interfered with the standard colorimetric analytical method. Therefore, during Phase 2B, several confirmatory soil and sediment samples were collected from the Site and analyzed for Cr(VI) using the standard method (USEPA Method 7196), an alternative method (USEPA Method 7199), and total chromium (USEPA Method 6010B). Six soil samples and three sediment samples were collected as part of this evaluation. The soil samples were collected from three previously sampled locations on the Dixie-Narco plant and three within the Imhoff wetland area. The sediment samples were collected from previously sampled locations within the intermittent Spur Branch. The Phase 2B analyses yielded similar results for Cr(VI), specifically no or low detections.

2.10.4 Pesticides and Polychlorinated Biphenyls

Pesticides were detected in samples collected during the RI. The reported concentrations of the detected pesticides were very low. The presence of pesticides in soil, sediment, and surface water samples can most likely be attributed to the historical use of pesticides in the agricultural areas surrounding the project site. Based on the minimal

concentrations detected in samples collected during Phase 1, only soil samples collected as part of the soil leaching to groundwater assessment, and newly sampled residential supply wells, were analyzed for pesticides during Phase 2 and 2b.

Samples collected during Phase 1 were analyzed for Polychlorinated Biphenyls (PCBs). PCBs were detected in only two samples (soil samples) collected during Phase 1 of the RI. Based on the minimal number of samples with PCBs detected during the initial phase of the RI, they were eliminated from the required analytical suite for all media during Phase 2 of the RI, except newly sampled residential supply wells. Pesticides and PCBs were not identified as COCs for the Site.

2.11 Soil Contamination

2.11.1 VOCs in Soils

Trichloroethylene (TCE) was the only VOC detected above its residential PRG (0.052 mg/kg) value in soil samples collected from the upland portion of the Site. TCE was only detected in the one soil sample 02TMW49AA at 0.08 mg/kg. It should be noted that this sample was collected from approximately 21 feet below land surface (BLS), within one foot of the water table in this boring.

2.11.2 SVOCs in Soils

During Phase 1, SVOCs were detected in six soil samples collected from the upland portion of the Site. Several PAHs were detected in the subsurface soil sample collected from SB9, beneath the sludge drying bed. However, none of the reported SVOC concentrations exceeded their respective residential PRGs. None of these PAHs were detected in the surficial sludge sample, collected from this SB9, just above the subsurface soil sample also from SB9. Based on the Phase 1 results, analysis for SVOCs was not required for samples collected during subsequent phases of work in the RI.

2.11.3 Metals in Soils

Fifty-one soil samples (five surface and forty-six subsurface) were collected from soil in the upland portion of the Site. Soil sample analytical results were compared to the USEPA Region 9 residential PRGs for samples collected from locations south of the Dixie-Narco plant (across Dixie-Narco Boulevard) and industrial PRGs for samples collected on the Dixie-Narco plant. Chromium concentrations detected in soil samples were compared to the hexavalent chromium residential PRG (30 mg/kg).

Only arsenic, chromium, and iron were detected at concentrations exceeding their USEPA Region 9 residential PRGs in soil samples collected from locations in the upland area. Arsenic was detected most frequently above its residential PRG (0.38 mg/kg) and its industrial PRG (1.59 mg/kg). Arsenic was detected above its residential PRG in 47 soil samples collected from upland locations south of the Dixie-Narco facility. Arsenic was detected above its industrial PRG in 36 soil samples collected from the Dixie-Narco

facility. Based on the widespread detection of arsenic in soils across the Site as well as in background sample locations, it appears that the persistent detection of this metal is related to ambient conditions in the area and is not Site related. Arsenic concentrations in background soil samples ranged from 0.72 mg/kg in the surface soil sample collected from BKSB02 to 4 mg/kg in the subsurface soil sample collected from the same background boring.

Iron was detected above its residential PRG (23,463 mg/kg) in 13 soil samples collected from the upland area. Twelve of these thirteen samples were collected from the subsurface (greater than one foot below land surface). Based on the soil conditions encountered in the upland portion of the Site, including the orange to red soil color and the presence of iron cementation in shallow subsurface soil, it appears that the iron concentrations are related to naturally occurring conditions beneath this portion of the study area. It is important to note that background iron concentrations range from 5,308 mg/kg in surface soils to 23,508 mg/kg in subsurface soil. Chromium was detected above the Cr(VI) residential PRG (30 mg/kg) in one surface and five subsurface soil samples collected during the RI. Chromium was detected in the surface soil sample 01TP4AA at 35.6 mg/kg. The five subsurface soil samples and their respective concentrations are as follows: 02MW4SAA at 84.5 mg/kg, 01TMWS12CA at 31.6 mg/kg, 01TP1CA at 76.7 mg/kg, 01TP2CA at 41.4 mg/kg, and 01TP4CA at 51.2 mg/kg. Sample 02MWS4BA was collected from a well boring installed on the northwest side of the Dixie-Narco plant. The remaining four subsurface soil samples were collected from the native soil beneath the waste in the equalization lagoon. Chromium was also detected above the Cr(VI) industrial PRG (64 mg/kg) in two of the soil samples listed above, 01MWS4AA and 01TP1CAA.

During Phase 2b of the RI, six sets of soil samples and three sets of sediment samples were collected from previously sampled locations at the Site in order to evaluate results obtained using two variations of an analytical method for Cr(VI). Hexavalent chromium was detected using both analytical methods in each of the soil samples collected during Phase 2b. The Cr(VI) values obtained using USEPA Method 7196 ranged from 0.84 mg/kg (TP1CA) to 2.5 mg/kg (MW07S). Cr(VI) values obtained using USEPA Method 7199 ranged from 0.28 mg/kg (TP1CA) to 0.65 mg/kg (MW01S). Total chromium concentrations ranged from 14.0 mg/kg (MW07S) to 17.4 mg/kg (MW01S). None of the reported Cr(VI) concentrations exceeded the total chromium values for any sample.

2.11.4 Pesticides and PCBs in Soil

Pesticides were detected in soil samples collected during Phase 1 of the RI. However, none of the reported concentrations exceeded their respective USEPA Region 9 residential PRGs in any of the samples. The PCB Aroclor 1260 was detected in only two samples collected from the Site during the RI. Aroclor 1260 was detected in the waste sample 01SB13AA from the sludge drying bed at 0.087 mg/kg and in the native soil sample from below the equalization lagoon, 01TP2CA at 0.047 mg/kg. Neither of these concentrations exceeds their respective residential PRGs. Based on the Phase 1 results, analysis for PCBs was not required for samples collected during subsequent phases of

work in the RI. Pesticides were also eliminated from the analyte list for future soil samples except for those collected as part of the soil leaching to groundwater investigation, performed during Phase 2.

2.12 GROUNDWATER CONTAMINATION

2.12.1 VOCs in Groundwater

Temporary Monitoring Well (TMW) groundwater samples collected during the RI were analyzed for TCL VOCs. Analytical results for the groundwater samples collected during the Phase 1A screening program were compared to MCLs to provide a perspective on the distribution of these constituents in groundwater. VOCs, including benzene, 1,1 dichloroethene (1,1 DCE), tetrachloroethylene (PCE), carbon tetrachloride (CT) and trichloroethene (TCE), were detected above their primary drinking water standards in shallow groundwater beneath the Site. TCE was detected above its MCL in a series of sample points across the Dixie-Narco plant. TCE was also detected above its MCL in samples from the transfer pipe area and in one sample from the Imhoff system wetland area.

Based on the results of the Phase 1A groundwater screening program, 31 monitoring wells (21 shallow and 10 deep) and eight temporary wells were installed during Phase 1B. The TMWs were installed to continue the delineation of VOCs in groundwater. Phase 1B groundwater screening results confirmed the presence of VOCs in shallow groundwater beneath the Dixie-Narco plant and delineated the extent of TCE in the shallow zone to the southeast of the Site.

Results of the initial groundwater sampling event for the monitoring well network (Phase 1B) indicated the presence of several VOCs above their respective MCLs in at least one well. These parameters include the VOCs: 1,1 DCE, PCE, TCE, CT, and dichloromethane.

TCE was detected above its MCL (5 µg/L) in 14 groundwater samples collected during Phase 1B, including three temporary monitoring wells and 11 monitoring wells. The TCE in shallow groundwater extends from MW2, located on the north side of the rear parking area, to MW17 located in the Imhoff system wetland area. TCE concentrations in the shallow groundwater zone range from 12 µg/L in MW17 to 210 µg/L in MW8. TCE concentrations are also present in two deep monitoring wells at the Dixie-Narco plant, MW5D at 65 µg/L and MW8D at 320 µg/L. The VOC 1,1 DCE was detected above its MCL (7 µg/L) in three monitoring wells: MW4 (9.9 µg/L), MW8 (17 µg/L) and MW8D (7.9 µg/L). CT was detected above its MCL (5 µg/L) in MW7 (15 µg/L) and MW11D (37 µg/L). Dichloromethane, a breakdown product of CT, was detected above its MCL (5 µg/L) in TMW48 (24 µg/L) and MW7 (5.4 µg/L). The extent of TCE and CT in the shallow zone in ground water is shown in Figures RD-7 and RD-9, respectively.

As a result of the Phase 1B groundwater sampling program, 11 TMWs and 25 MWs were installed at the Site during Phase 2. Phase 2 groundwater screening results delineated the

source area for TCE in groundwater beneath the Dixie-Narco plant and to the northwest. The highest TCE concentration detected in groundwater beneath the Site (410 µg/L) was detected in TMW56, installed nearest the former forklift repair shop. Therefore, the forklift repair shop, located on the northwest side of the Dixie-Narco plant, is believed to be the source area for TCE in groundwater beneath the Site. Phase 2 groundwater screening results indicated that elevated TCE concentrations were present in deeper groundwater beneath the northeast portion of the Imhoff wetland area (TMW53 at 28 µg/L).

During Phase 2 of the RI, the original MW network (31 wells) as well as the newly installed MWs (25 wells) were sampled to provide additional groundwater quality data for the Site. Groundwater samples collected during Phase 2 were analyzed for TCL VOCs and several fate and transport parameters. A subset of the groundwater samples collected during Phase 2 were also analyzed for monitored natural attenuation (MNA) parameters.

Comparison of the analytical results from the Phase 2 MW sampling event to MCLs, indicated that four VOCs (benzene, CT, PCE, and TCE) were detected above their respective MCLs. Benzene was detected above its MCL of 5 µg/L in MW4 (57 µg/L). CT was detected above its MCL (5 µg/L) in one shallow well, MW7 (22 µg/L) and six D zone wells: MW11D, MW15D, MW16D, MW19D, MW24D and MW31D. PCE was detected above its MCL (5 µg/L) in one shallow well, MW4 (11 µg/L) and one D zone well, MW8D (9.2 µg/L). TCE was detected above its MCL (5 µg/L) in 18 MW samples collected during Phase 2. Elevated TCE concentrations in the shallow zone ranged from 5.8 µg/L in MW14 to 230 µg/L in MW27. Results of the investigation of the shallow zone indicates that TCE extends from the source area, near MW27, to the southeast beneath the Imhoff wetland area. TCE does not appear to reach beyond the Imhoff wetland area in the shallow groundwater.

During Phase 2b, 24 additional TMWs were installed to define the extent of TCE and CT in the D zone beneath the Site. TCE was detected in the D zone to the southeast of the Dixie-Narco plant, beyond Charleston Street and beneath a private parcel of property. The extent of TCE in the deep zone in ground water is shown in Figure RD-8. The extent of CT in the D zone was also delineated beneath the southwest portion of the Site. As a result of the TMW program during Phase 2B, eight new MWs (MW32D through MW39D) were also installed to the east and southeast of the Dixie-Narco plant. Sampling of the newly installed MWs detected TCE above its MCL in two samples, MW36D (11 µg/L) and MW38D (110 µg/L). TCE in the D zone extend from the source area (MW27 cluster) to the east-southeast, across Charleston Street and beneath a parcel of private property.

CT is present in the D zone extending from a parking area across from the Dixie-Narco plant to the east and southeast to the Imhoff wetland area. CT concentrations in the D zone do not appear to extend beyond the Imhoff wetland area. The extent of CT in the deep zone in ground water is shown in Figure RD-10.

2.12.2 SVOCs in Groundwater

During Phase 1B, only one SVOC (benzo(g,h,i)perylene) was detected in groundwater samples collected from permanent monitoring wells at the Site. This SVOC was detected in MW2 at 1.9 µg/L. There is not an MCL for benzo(g,h,i)perylene. Since only one SVOC was detected in groundwater beneath the Site during Phase 1B, SVOCs were eliminated from future groundwater sampling events.

2.12.3 Metals in Groundwater

During Phase 1A, groundwater samples collected from TMWs were analyzed for the metals chromium, lead, nickel, and zinc. Lead was detected above its MCL (15 µg/L) in three TMW groundwater samples: TMW12 (49.8 µg/L), TMW21 (17.6 µg/L), and TMW35 (17.4 µg/L). Nickel was detected above its health advisory (100 µg/L) in two groundwater samples collected during Phase 1A, TMW37 (262 µg/L) and TMW40 (576 µg/L). Note, nickel no longer has an MCL, but the 100 µg/L has been retained as a life time health advisory. Health advisories are provided as guidance for regulators but are not a legally enforceable federal standard. Based on the limited number of metals detected during Phase 1, subsequent groundwater screening locations were not sampled for TCL metals.

Results of the initial permanent monitoring well sampling event (Phase 1B) reported a limited number of metals (nickel, lead, and antimony) above their respective MCLs. The metals lead and antimony were detected above their MCLs of 15 µg/L and 6 µg/L, respectively, in only one well each: lead in TMW49 at 15.8 µg/L, and antimony in MW4D at 7.2 µg/L. Nickel was detected above its health advisory (100 µg/L) in three monitoring wells in the Imhoff system wetland area, at MW15 (774 µg/L), MW16 (132 µg/L) and MW20 (112 µg/L).

As a result of the detection of nickel concentrations above the health advisory level in the Imhoff wetland area during Phase 1B, two additional shallow monitoring wells (MW22 and MW23) were installed to the south of the wetland area. During the Phase 2 sampling event, nickel was detected above its health advisory level in only well, MW15 at 157 µg/L.

During the Phase 2 well installation program, ten MWs were installed at the project site in an attempt to determine if the project site is the source of mercury found in a series of residential water supply wells located to the northeast of the Site. The wells, MW5D2, MW5D3, MW8D2, MW8D3, MW29D2, MW29D3, MW30, MW30D, MW30D2, and MW30D3, were installed at depths ranging between 85 and 100 feet bls, for D2 wells, and 115 and 126 feet bls for D3 wells. Mercury was not detected in any of the samples collected from these wells.

Mercury was detected in ten shallow and five D zone monitoring wells sampled during Phase 2(a) of the RI. None of the mercury concentrations detected in the shallow

monitoring wells during the Phase 2(a) sampling event exceed the mercury MCL of 2 µg/L. The shallow wells and their respective mercury concentrations are as follows:

MW3	0.054J µg/L
MW4	1.5 µg/L
MW5	0.86 µg/L
MW6	0.051J µg/L
MW7	0.05J µg/L
MW8	0.27 µg/L
MW9	0.1J µg/L
MW10	0.054J µg/L
MW27	0.28 µg/L

The concentrations listed with a "J" are estimated concentrations.

The D zone monitoring wells in which mercury was detected during Phase 2, and their respective concentrations are as follows:

MW8D	1 µg/L
MW12D	0.054J µg/L
MW15D	0.13J µg/L
MW37D	5 µg/L
MW38D	0.19J µg/L

As indicated above, mercury was detected above its MCL in MW37D (5 µg/L) which was installed during Phase 2B of the RI. MW37D was installed off-site and adjacent to RW7 and in the vicinity of the residential supply wells located northeast of the Dixie-Narco plant. Mercury was not detected in any of the D2 or D3 zone monitoring wells.

2.12.4 Pesticides and PCBs In Groundwater

Seven pesticides were detected at very low concentrations in groundwater samples collected from the Site during Phase 1B. PCBs were not detected in any groundwater samples collected from the Site. PCBs and pesticides were not included in the analytical suite for groundwater during subsequent phases of investigative activities at the Site.

2.12.5 Residential and Municipal Supply Wells

As part of the RI, a survey was conducted to locate all municipal and residential water supply wells within a one-mile radius of the center of the project site. Sixty municipal and residential supply wells were located. Once the wells were sampled they were assigned an identification number ranging from RW1 through RW60. Two of these wells (RW9 and RW10) are the Town of Williston municipal supply wells. The remaining 58 wells are residential supply wells used by individual property owners. Fifty-three wells were sampled during Phase 1 of the RI. During Phase 2, permission was granted by property owners to sample seven additional supply wells (RW54, RW55, RW56, RW57, RW58, RW59, and RW60), so these wells (Figure RD-3) were sampled for the first time during Phase 2. During initial sampling, samples from each supply well were analyzed for the TCL/TAL suite of parameters as well as Cr(VI), hardness and pH. Water supply well sample results were screened against the MCLs established by the USEPA. During the RI, three constituents were detected above their respective primary drinking water standards in supply well samples. Some of the residential supply wells were re-sampled to confirm these results. During this resampling, the residential supply wells were sampled for a focused list of parameters. Supply well sampling results are discussed below.

2.12.6 VOCs in Residential and Municipal Supply Wells

Of the 60 supply wells sampled during the RI, only one (RW57), has been found to contain a concentration of any VOC above an MCL. TCE was detected above its MCL of 5 µg/L in RW57 at 17 µg/L, which was collected during Phase 2(a). Minimal concentrations (concentrations as estimated values reported below method detection limits) of seven VOCs (chloroform, 1,1 DCA, chloromethane, carbon disulfide, dichloromethane, PCE, and xylenes) were reported in one or more residential supply well samples collected during the RI . None of these VOCs were detected above their respective MCLs .

During Phase 2B, additional samples were collected from supply wells RW1, RW5, RW6, RW7, RW8, RW23, and RW49 located along the boundary of the TCE plume in the D zone groundwater. TCE and 1,1,DCA were detected at trace concentrations in four of these samples, but no VOCs were detected above their respective MCLs in any of these samples.

2.12.7 SVOCs in Residential and Municipal Supply Wells

During Phase 1, only one SVOC (benzo(a)pyrene) was detected above its MCL in any of the supply wells sampled during the RI. Benzo(a)pyrene was detected above its MCL of 0.2 µg/L in one residential supply well (RW13). The chemical analysis performed can detect PAHs by using either: 1) the TCL SVOC scan (SW 846 Method 8270) or 2) by using the PAH scan (SW 846 Method 8310). Benzo(a)pyrene at RW13 was detected via the TCL SVOC scan at an estimated concentration 0.0009 milligrams per liter (mg/L). The quantitation limit in the USEPA approved Quality Assurance Project Plan (QAPP) for this compound using the TCL SVOC scan is 0.010 mg/L, which is above the MCL for this compound. However, this parameter was not detected in the PAH scan. The

quantitation limit for this compound utilizing SW 846 Method 8310 is 0.0002 mg/L. This well was re-sampled for benzo(a)pyrene at the end of Phase 1A; benzo(a)pyrene was not detected by either analytical method upon re-sampling. Based on these results, benzo(a)pyrene is not considered present above the MCL in this residential well. Seven other SVOCs were detected in supply well samples collected during the RI. None of these compounds were detected above their respective MCLs.

2.12.8 Metals in Supply Wells

Mercury has been detected in 11 of the 60 supply well samples collected during the RI. Mercury was detected above its MCL in two groundwater samples collected from supply wells during Phase 1 (RW7 and RW28). It was initially detected above its MCL (2 µg/L) in the sample from RW28 (3.3 µg/L) and just below its MCL in RW1 (1.9 µg/L) and RW7 (1.6 µg/L). Mercury was detected below its MCL and at lower concentrations in two other supply wells in the vicinity of RW28, RW5 (0.00055 mg/L) and RW49 (0.00037 mg/L).

SCDHEC and USEPA required the collection of additional samples from RW1, RW7 and RW28, the three wells with the highest concentrations of mercury. The samples from these wells were analyzed for total mercury. Results from the re-sampling event indicate that mercury was present above its MCL in RW28 (2.7 µg/L) and RW7 (3.1 µg/L) and below its MCL at RW1 (1.3 µg/L).

Mercury was also detected in two residential supply wells located to the southwest of the Site, RW18 (0.12µg/L) and RW25 (0.068 µg/L). These mercury concentrations are below the mercury MCL (2 µg/L). Mercury was not detected in the two background supply wells, RW11 and RW12.

In order to further evaluate the presence of mercury in these residential supply wells and to evaluate the aquifer geochemistry, additional samples were collected from RW1, RW5, RW6, RW7, RW14, RW28, RW32, RW33, RW49, RW52, and RW57 during Phase 2. During this sampling, mercury was detected in eight of the 12 supply wells. Mercury was detected above its MCL of 2 µg/L only in samples collected from RW7 (4.1 µg/L) and RW28 (2.8 µg/L).

As discussed above in the VOC discussion, additional samples were collected from RW1, RW5, RW6, RW7, RW8, RW23, and RW49 during Phase 2B. Mercury was detected above its MCL in RW5 (2.1 µg/L), RW7 (5.1 µg/L), and RW49 (3.5 µg/L) during this Phase 2B sampling event. The reported mercury concentrations in each of these wells are higher than the previous results for these wells as sampled during Phase 2.

Iron was also detected above its Secondary Maximum Contaminant Limit (SMCL) of 0.3 mg/L in 12 of the residential supply well samples collected during RI. Exceedances of the SMCLs may have a less than desirable aesthetic or cosmetic effect on water quality but do not pose an adverse health effect. No other metals have been detected above their respective MCLs in water supply well samples collected during the RI.

2.12.9 Pesticides and PCBs Results for Supply Wells

Neither pesticides nor PCBs have been detected in supply well samples collected during the RI.

2.12.10 Other Parameters

Several of the supply wells sampled during the RI have a pH lower than the secondary drinking water standards range of 6.5 to 8.5 and ranged between 4 in RW1 to 6.4 in RW 38. This condition has been encountered in 48 of the 58 residential supply wells sampled during the project. It should be noted that the pH values for the samples collected from the two public supply wells operated by the Town of Williston (RW 9 and RW10) were within the SMCL range.

2.13 Hydric Soil Contamination

All parameter concentrations in hydric soil samples have been compared to their respective USEPA Region 9 PRGs for residential soils and industrial soils to provide a perspective on the distribution of these constituents in soils. Total chromium concentrations are compared to the more conservative hexavalent chromium PRG (30 mg/kg).

2.13.1 Imhoff System Wetland Area

Either surface or subsurface soil samples were collected from the Imhoff wetland area during each phase of the RI. Surface soil samples were collected from 25 locations in this area during Phase 1A. These samples were analyzed for chromium, lead, nickel, and zinc. Surface and subsurface soil samples were collected from 10 previously sampled locations and 15 new locations during Phase 1B. These samples were analyzed for the TCL/TAL suite of parameters. Surface soil samples were collected from seven previously sampled locations during Phase 2 as part of the ecological evaluation. Samples were also collected from three of these locations as part of the soil leaching to groundwater investigation. Surface soil samples were also collected from five previously sampled locations during Phase 2B to provide additional data to support the soil leaching to groundwater investigation. .

2.13.2 VOCs in Imhoff System Wetland Area Soils

VOCs were detected in soil samples collected from this area during Phase 1B. None of the reported VOC concentrations exceeded their respective USEPA Region 9 residential PRGs. Three of the soil samples collected from this area during Phase 2 (SS5, SS12, and SS15) were also analyzed for a limited list of VOCs as part of the SSL evaluation for soils at the Site None of the VOCs detected in these samples exceed their respective residential PRGs. Imhoff system area wetland soils were not sampled for VOCS during Phase 2B.

2.13.3 SVOCs in Imhoff System Wetland Area Soils

Imhoff system wetland area soils were not sampled during Phase 1A. Ten SVOCs were detected in soil samples collected from the Imhoff wetland area: benzyl-butyl phthalate, carbazole, phenol, bis(2ethylhexyl)phthalate, dibenz(a,h)anthracene, benzo(a)pyrene, bis-(2chlorethyl)ether, hexachloroethene, Di-n-octyl phthalate, flouranthene, benzo(g,h,i)pyrilene, and indeno (1,2,3-cd) pyrene. Two of the SVOCs were detected above their respective USEPA Region 9 residential PRGs in soil samples collected from the Imhoff system wetland area during Phase 1B. Benzo(a)pyrene was detected in SS8 at 0.13 mg/kg which exceeds its residential PRG of 0.062 mg/kg. Dibenz(a,h)anthracene was detected in SS13 at 0.076 mg/kg, which exceeds its residential PRG of 0.062 mg/kg. No other SVOCS were detected above respective residential PRGs in soil samples collected from this area. Imhoff system area wetland soils were not sampled for SVOCS during Phase 2B.

2.13.4 Metals in Imhoff Wetland Area Soils

During Phase 1A, only arsenic, chromium, iron, nickel and zinc were detected above their respective USEPA Region 9 residential PRGs in soil samples collected from this area. The metal most commonly detected above its residential PRG is chromium. Results from the soil screening program performed during Phase 1A indicated that chromium exceeded its residential PRG at 30 of the 44 hydric soil sample locations within the Imhoff system wetland area. Soil sampling during Phase 1B defined the limits of site related metals along the western and southern sides of the Imhoff wetland area. During Phase 2, the limits of site related metals were also defined along the northwest corner of the Imhoff wetland area.

The limits of site related metals were not defined along the eastern side of the Imhoff system wetland area where it meets the intermittent stream wetland area. Therefore, during Phase 2B, additional surface and subsurface soil samples were collected between the eastern edge of the Imhoff wetland area and Charleston Street to determine the horizontal and vertical extent of site related metals in this area.

RI sampling results indicate that arsenic is present throughout the entire study area in both surface and subsurface samples and appears to be naturally occurring. The residential PRG for arsenic is 0.389 mg/kg. The background concentrations for arsenic in hydric soils range from 1.968 mg/kg in surface soil to 5.32 mg/kg in subsurface soils. It is important to note that both background concentrations exceed the residential and industrial PRGs for arsenic.

Total chromium was detected at concentrations exceeding the hexavalent chromium residential PRG in 30 of the surface soil samples. Chromium was detected above the referenced residential PRG in eight subsurface soil samples collected from the Imhoff system wetland area. It is important to note, however, that none of the total chromium

concentrations detected in the surface or subsurface soil samples exceed the residential PRG of 100,000 mg/kg for trivalent chromium.

The hexavalent chromium and total chromium data was evaluated to determine if hexavalent chromium is present at the Site. Review of this data indicted that the hydric soils and sediments at the Site are reducing and that under these conditions chromium is likely to be present in the trivalent form and not the hexavalent form. Additionally, the analytical method used for hexavalent chromium is a colorimetric test and interference from the natural color of the samples resulted in a potential level of error in the sample results. This error is likely to be biased high. A high bias was confirmed by: (1) the presence of hexavalent chromium in background samples, where it would not be expected, and (2) sample results of reported levels of hexavalent chromium higher than the level of total chromium. Hexavalent chromium concentrations as detected using USEPA Method 7199 ranged from 0.8 mg/kg in SD6 to 18.6 mg/kg in SD3. Total chromium concentrations ranged from 58.6 mg/kg in SD6 to 2820 mg/kg in SD4. Hexavalent chromium was not detected in any of the sediment samples using USEPA Method 7196. This evaluation indicates that hexavalent chromium should not be considered a constituent of concern in the sediment and hydric soil at this site.

Nickel exceeded its USEPA Region 9 residential PRG (1564 mg/kg) in surface soil samples collected from the center of the Imhoff System wetland area, but nickel did not exceed the industrial PRG value (20,439 mg/kg). The horizontal extent of nickel concentrations has been delineated in all directions within the Imhoff wetland area. Nickel was not detected above its USEPA Region 9 residential or industrial PRG in subsurface soil. Zinc was detected above its USEPA Region 9 residential PRG (23,463 mg/kg) in only two surface soil samples collected from the Imhoff System wetland area and it was not detected above its industrial PRG (100,000 mg/kg) in surface soil. Zinc was not detected above its USEPA Region 9 residential PRG in any subsurface soil samples collected from the area. The metals chromium, nickel, and zinc were also detected above their respective USEPA freshwater sediment ecological screening values.

2.13.5 Pesticides and PCBs in Imhoff Wetland Samples

Pesticides were detected in soil samples collected from this portion of the Site. Pesticides have not been detected above their respective USEPA Region 9 residential PRGs in soil samples collected from this area. PCBs were not detected in any samples collected from this portion of the Site.

2.13.5.1 Intermittent Stream Wetland Area

No hydric soil samples were collected from the intermittent stream wetland area during Phase 1A, Phase 1B, or Phase 2. During Phase 2B, hydric soil samples were collected from 37 locations in the intermittent stream wetland area between the Imhoff wetland area and Charleston Street. Each of these samples were collected from a series of transects crossing the stream. Each sample was analyzed for chromium, copper, nickel,

and zinc. Only the metal chromium was detected above its respective USEPA Region 9 residential PRG in the hydric soil samples collected from this portion of the study area.

Chromium is the only metal detected above its residential PRG (30 mg/kg) in the hydric surface soil samples collected from the intermittent stream wetland area. Chromium concentrations above the USEPA Region 9 residential PRG ranged from 273 mg/kg in SS74 to 1980 mg/kg in SS65.

Subsurface soil samples were also collected from 13 of the intermittent stream sample locations. None of the four metals were detected above their respective USEPA Region 9 residential PRGs in any of the subsurface soil samples.

2.13.5.2 Willis Millpond, Spillway, and Spur Branch

As a result of the breach of the Willis Millpond dam, the investigation of hydric soil was expanded near the pond and in material washed downstream from the pond during Phase 2. Four hydric soil samples (SS45 through SS48) and one sediment sample (SD49) were collected from Spur Branch downstream of Willis Pond Road. Additionally, three sets of surface and subsurface soil samples (SS50 through SS52) and one sediment sample (SD48) were collected from the pond spillway area. Six hydric soil samples were collected from locations adjacent to the pond (SS53 through SS58). Only the metals arsenic and iron were detected above their respective USEPA Region 9 residential PRGs in any of the soil samples collected from this portion of the Site. Arsenic concentrations above the USEPA Region 9 residential PRG (0.39 mg/kg) ranged from 0.67 mg/kg in SS48 to 9.8 mg/kg in SS58. Iron was detected above its residential PRG (23,463 mg/kg) in only one sample (SS57). Three of the hydric soil samples collected from Willis Millpond were also analyzed for toxicity as part of the ecological evaluation.

2.14 Sediment Contamination

Sediment samples were collected during the RI from background locations, the intermittent Spur Branch stream, perennial Spur Branch stream, Willis Millpond, the Dorch Pond, and Bolen Bay. The sediment samples analytical results were screened against human health and ecological based criteria. The human health screening criteria utilized for comparison are the USEPA Region 9 PRGs for residential soils. Chromium concentrations are compared to the more conservative USEPA Region 9 residential PRG (30 mg/kg) for Cr(VI). The ecological screening criteria utilized for comparison are the USEPA Region 4 sediment quality benchmarks.

2.14.1 VOCs in Sediment Samples

A limited number of VOCs were detected in sediment samples collected during Phase 1A and 1B of the RI: acetone, 2-butanone, bromomethane, carbon disulfide, toluene, 1,2 dichloroethane, 2-hexanone, chloroform, chloromethane, styrene, tribromomethane. None of the reported VOC concentrations exceeded their respective USEPA Region 9 residential PRGs. Based on the limited number of VOCs detected in sediment samples

collected during Phase 1A and 1B, none of the sediment samples collected during subsequent sampling events were analyzed for VOCs.

2.14.2 SVOCs in Sediments

Three polynuclear aromatic hydrocarbons (PAHs) were detected in sediment sample SD-51 above their respective USEPA Region 9 residential PRGs. The PAHs, their respective residential PRGs and reported concentrations are: benzo(a)anthracene of 0.72 mg/kg (residential PRG 0.62 mg/kg), benzo(a)pyrene of 0.68 mg/kg (residential PRG 0.062 mg/kg), and dibenzo(a,h)anthracene of 0.22 mg/kg (residential PRG 0.062 mg/kg). It should be noted that this sample location is approximately 125 feet south (downstream) from Dixie-Narco Boulevard. This sample point likely receives run-off from Dixie-Narco Boulevard during rain events which could be the source of the PAHs in the sediment samples.

No other SVOCs were detected in sediment samples above their respective PRGs.

2.14.3 Metals in Sediment Samples

Arsenic was detected above its USEPA Region 9 residential PRG (0.38 mg/kg) in 36 of the 60 sediment samples collected during the RI. Arsenic concentrations ranged from 0.42 mg/kg in SD51 to 9.5 mg/kg in SD59. Arsenic is present throughout the area in surface soils, subsurface soils and sediment samples and appears to be naturally occurring. Background arsenic concentrations in sediment samples range from 1.7 mg/kg in stream sediment to 5 mg/kg in hydric soil/sediment samples. Therefore, the results of sediment sampling in this area show that arsenic is detected at background concentrations.

Chromium was detected above its residential PRG of 30 mg/kg in samples from 20 locations sampled during the RI. Chromium concentrations in sediment samples ranged from 90.7 mg/kg in SD31 to 2770 mg/kg in SD4. Based on review of RI sediment data, the highest concentrations of chromium are found in the intermittent Spur Branch from the Imhoff wetland area down to Charleston Street.

Iron was detected above its residential PRG of 23,463 mg/kg in three sediment samples collected from the Willis Millpond. These iron concentrations were 32,200 mg/kg in SD45, 26,600 mg/kg in SD46, and 28,300 mg/kg in SD47. Background iron concentrations range from 1180 mg/kg in perennial stream sediment (BKSD8) to 6300 mg/kg in intermittent stream sediment (BKSD3 and BKSD4) to 11,470 mg/kg in pond sediment (BKSD1 and BKSD2), to 22,200 in hydric soil/sediment samples (BKSD9 and BKSD10). It appears, based on these background concentrations, that the iron concentrations detected in this area are related to naturally occurring conditions in this portion of the study area.

The metals chromium, nickel, and zinc were detected above their respective USEPA freshwater sediment ecological screening values.

2.14.4 Pesticides and PCBs in Sediments

Pesticides were detected in sediment samples collected from the Site, including background sediment samples. None of the reported pesticide concentrations exceed their respective USEPA Region 9 residential PRGs. PCBs were not detected in any of the sediment samples that were analyzed for these compounds. Based on the limited pesticide concentrations and the lack of PCBs in sediment samples collected during Phase 1, none of the sediment samples collected during subsequent sampling events were analyzed for these parameters.

2.15 Surface Water Contamination

A total of 49 surface water samples were collected from the project site. Surface water sample analytical results have been compared to the USEPA Human Health Ambient Water Quality Criteria (HHAWQC), and against ecological screening values.

2.15.1 VOCs in Surface Water

Very few VOCs (TCE, bromomethane, chloromethane) were detected in surface water samples collected from the Site during Phases 1A and 1B of the RI. None of the reported VOC concentrations exceeded their respective HHAWQCs in surface water samples. Based on the limited detection of VOCs in surface water samples collected during Phase 1, they were eliminated as an analyte for any surface water samples collected from previously sampled locations during Phase 2 of the RI. Locations sampled for the first time during Phase 2 included background locations BKSW2, BKSW3, and BKSW4. Each of these samples was analyzed for TCL VOCs. None of these compounds were detected in these Phase 2 samples.

2.15.2 SVOCS in Surface Water

The SVOCs bis(2-ethylhexyl)phthalate, benzo(a)pyrene, benzo(b)flouranthene, benzo(k)flouranthene and chrysene were detected in at least one surface water sample above their respective HHAWQC values in samples collected during Phases 1A and 1B. Bis(2-ethylhexyl)phthalate was detected above its HHAWQC value (1.2 µg/L) in SW24 at 3 µg/L and in SW19 at 31 µg/L. The PAHs benzo(a)pyrene (0.012 µg/L), benzo(b)flouranthene (0.012 µg/L), benzo(k)flouranthene (0.019 µg/L) and chrysene (0.023 µg/L) were detected only in SW38 above their respective HHAWQCs (0.0038 µg/L).

Based on the limited detection of SVOCs in surface water samples collected during Phase 1, they were eliminated as an analyte for any surface water samples collected from previously sampled locations during Phase 2 of the RI.